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REPORT NO. R-1467

DATE 12 August 1938

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SUBJECT [redacted]

Ultra-Violet Signalling Equipment,

Tests of January 1938.

BY [redacted]

NAVAL RESEARCH LABORATORY

BELLEVUE, D. C.

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NAVY DEPARTMENT

[redacted] BUREAU OF ENGINEERING

Report

on

Ultra-Violet Signalling Equipment,

Tests of January 1938.

NAVAL RESEARCH LABORATORY
ANACOSTIA STATION
WASHINGTON, D.C.

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Authorization: BuEng. secret ltr. S-S64-5 (6-4-W9) Serial No. 87, of 7 July 1937.

Date of Test: January 26-27, 1938.

Reported by: _____
E. O. Hulburt, Principal Physicist,
Superintendent,
Physical Optics Division.

Approved by: _____
L. K. Swenson, Commander, USN,
Acting Director.

Distribution:
BuEng. (3)

ejh [redacted]

Table of Contents

Appendices

ABSTRACT

Ultra-violet transmitters were made of the General Electric Company Type H-3 high pressure, high intensity, mercury lamp screened by an ultra-violet filter of Corning "Violet Ultra" black glass. The transmitted radiation was almost entirely the mercury 366 μμ ultra-violet line. The ultra-violet receivers were fluorescent telescopes. Tests of the equipment at night between a destroyer and a submarine showed that the range with the ultra-violet telescope was about 4800 yards and with ordinary binoculars about 3200 yards. It was concluded that the ratio of the ultra-violet telescope range to binocular range was too small to give desired security and therefore that the equipment was not suitable for Service application.

Experiments are underway to determine the sensitiveness of photo-electric tube counters as detectors of ultra-violet signals.

AUTHORIZATION

1. The tests were authorized by Bureau of Engineering secret letter S-S64-5 (6-4-W9) Serial No. 87, of 7 July 1937, to Director, Naval Research Laboratory.

REFERENCES

2. References pertinent to this report are:

Reference: (a) Naval Research Laboratory Report No. H-1017 of 18 January 1934, "Signalling and Detection with Ultra-Violet and Infra-Red Radiation."

(b) NRL secret ltr. S-S89/S64-5 of 4 June 1937, to Bureau of Engineering.

(c) BuEng. secret ltr. S-S64-5 (1-28-W) Serial No. 157, of 1 February 1938, to Director, NRL.

INTRODUCTION

3. Investigations at this Laboratory on ultra-violet signalling, described in reference (a), indicated that an ultra-violet system, although in some respects promising, required further development before it could claim consideration as of possible Naval use. In particular, it was brought out that the ultra-violet wave-lengths employed in the system were not completely invisible and that the high pressure quartz mercury lamp was a most efficient source of the wave-lengths. However, such lamps were not available commercially and rather than to undertake their development at this Laboratory, it was decided to wait until some company got around to making them. This occurred about two years ago when the General Electric Company placed on the market their Type H-3 mercury lamp. Equipment was made up using this lamp and was tested as described in the following paragraphs.

4. It was contemplated that the ultra-violet equipment might be useful for night navigation, as station keeping, and for secret signalling at night; it was not believed that the equipment offered any application to the problem of emergency night recognition.

APPARATUS

5. The apparatus, reference (b), is shown in Plate 1, and consisted of a small ultra-violet transmitter and small ultra-violet telescopes for receiving, shown in the right and left portions of Plate 1, respectively. An ultra-violet telescope

was fixed on top of the transmitter, and pointed in the direction of the transmitted beam, in order that the operator of the transmitter be able to receive signals.

6. The transmitter consisted of the General Electric Company H-3 high intensity, high pressure, mercury lamp in a housing with a parabolic reflector, and an ultra-violet filter to absorb the visible light. Three lenses were provided to give three widths of beam, 10°, 25°, and 40°, as shown in Column 2, Table 1. The ultra-violet filter was a disk of Corning "Violet Ultra"

Table 1

Lens	Width of Beam	Relative Intensity
No. 1	10°	10
2	25°	5
3	40°	2

black glass, one centimeter thick, which was transparent to the strong ultra-violet mercury line 366 μμ and was opaque to visible light. In Plate 2 is shown a spectrum of the open H-3 lamp and of the H-3 lamp through the ultra-violet filter. It is seen that the light emitted by the transmitter consisted only of the mercury line 366 μμ. The H-3 lamp ran on 60 cycle alternating current and absorbed 300 watts; it had a rated life of 500 hours. It was satisfactory in all respects of operation and was a very efficient source of 366 μμ ultra-violet light.

7. The ultra-violet telescopes were small four power telescopes of good optical design with a fluorescent film at the focus of the objective lens. The fluorescent substance used in the film was developed in this Laboratory and was the most efficient known. Although the fluorescent nature of the substance has been noted in scientific literature, the substance is rarely to be found in chemical stock rooms, and the excellence and stability of its fluorescent properties are not matters of common knowledge.

TEST OF JANUARY 26-27, 1938.

8. The equipment was tested on the night of January 26-27, 1938, by a destroyer and submarine on Chesapeake Bay, reference (c). A transmitter and four ultra-violet telescopes were on each ship. The conditions for the test were good, the night being dark and the weather clear; the ships were darkened. One ship lay to and the other moved slowly to various ranges. The results are given in Table 2. It is seen that the maximum range with the ultra-violet telescope was only about 50, 24, and 9 per cent greater than the range with ordinary binoculars for lenses 1, 2, and 3, respectively. In other words, the ultra-violet light could be seen with ordinary binoculars nearly as far as it could be seen

Table 2

Lens	Maximum Range Unaided Eye	Maximum Range Binoculars	Maximum Range Ultra-Violet Telescope
No. 1	1650 yards	3200 yards	4800 yards
2	800	2500	3100
3	350	715	780

with the ultra-violet telescope. This was true, however, for youthful observers or for those with good ultra-violet vision. In general, the ultra-violet sensitivity of the eye varies with different observers and decreases with increasing age.

CONCLUSION FROM THE TEST

9. It was concluded, reference (c), that the ratio of ultra-violet telescope range to binocular range was too small to give desired security, and therefore that the equipment in its present stage of development was not suitable for Service application.

10. It is noted that the conclusion is based on a single period of experimentation.

DIRECTION OF FURTHER EXPERIMENTS

11. The most direct way to increase the ratio of the ultra-violet to the visible range would be to discover a more sensitive ultra-violet fluorescent substance. Whether such a discovery can be made is speculative; this Laboratory is not attempting it. A new means of detecting ultra-violet light has been developed in recent years which is exceedingly sensitive. The means is instrumental and consists of photo-electric tube counters with appropriate amplifying circuits. Dr. G. L. Locher of the Bartol Research Foundation, The Franklin Institute, Philadelphia, has demonstrated at this Laboratory some very sensitive tube counters of his own manufacture, the nature and properties of which he claims, correctly, are known only to him. Three tube counters have been purchased from Dr. Locher, and investigation of their possibilities has begun. The results of the investigation will be submitted in a future report. One thing may be said in advance. The most appealing feature of the ultra-violet telescope as a receiver or detector of ultra-violet signals was its extreme simplicity of use. In turning from it to an instrumental method the feature of simplicity is lost.

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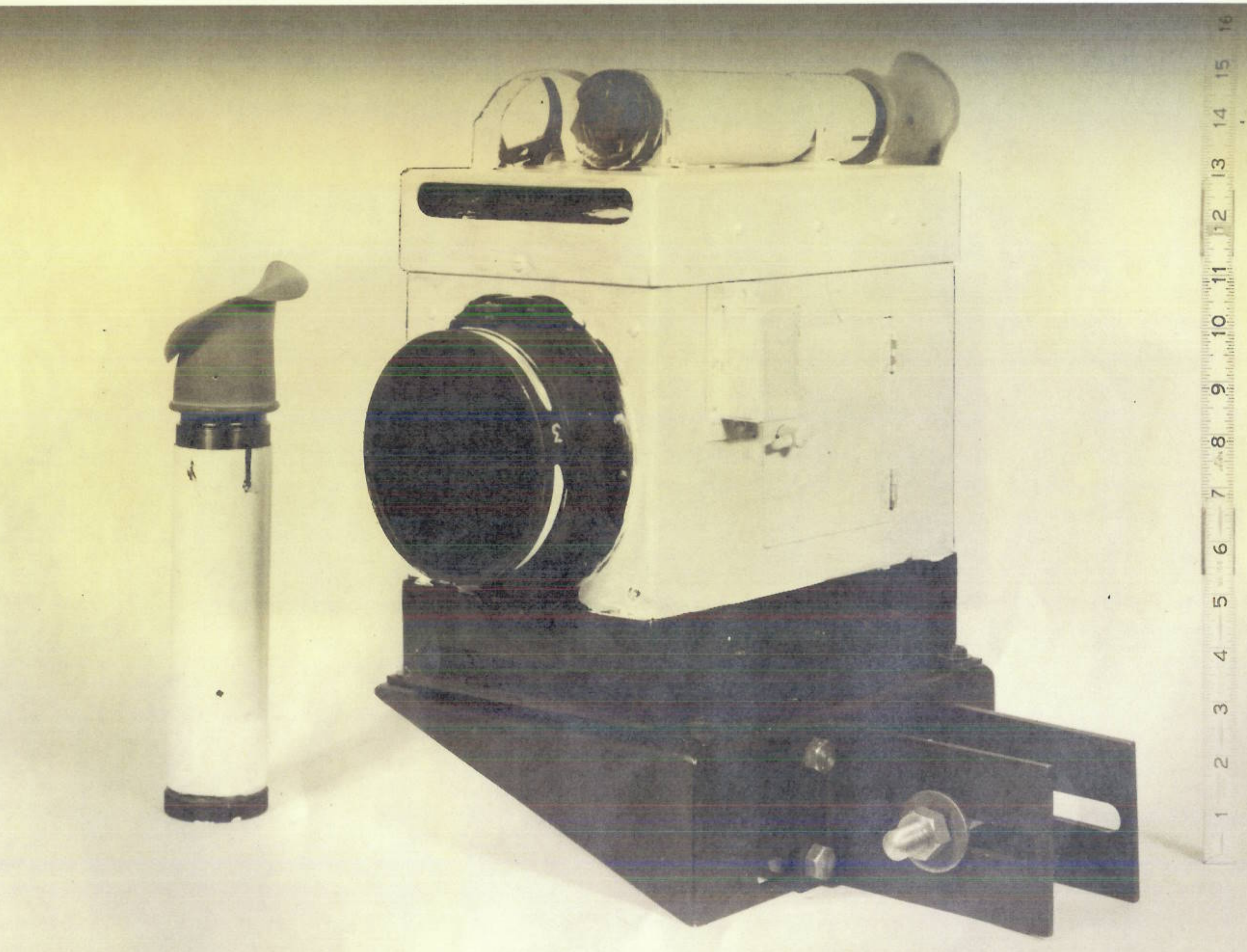
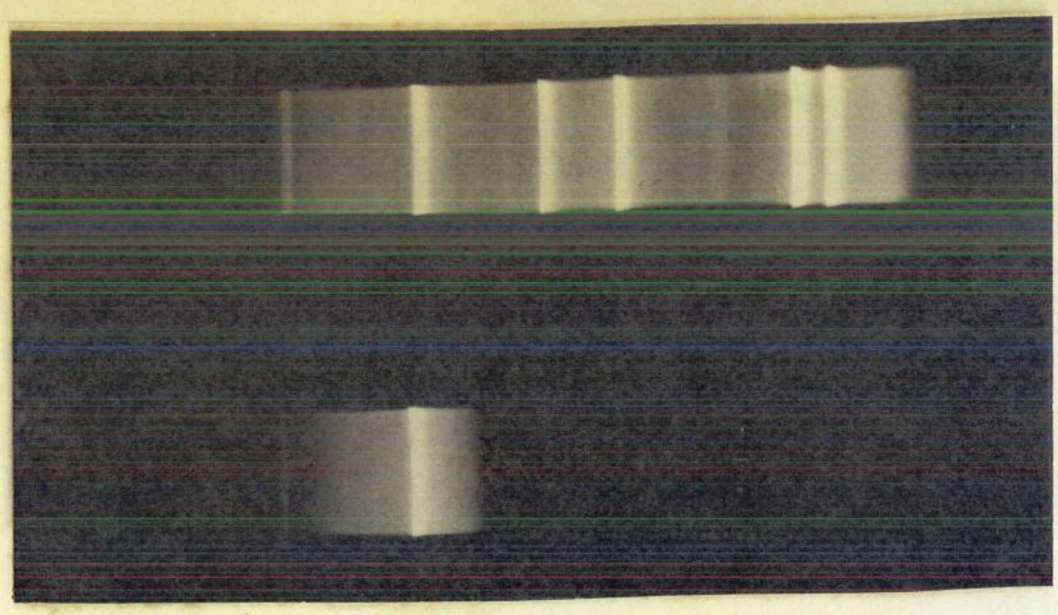
PLATE 1



Ultra-violet Transmitter and Receiver.

[redacted]

334. 366 ultra-viol 405 violet. 434 blue. 544 green. 577 yellow.



H-3 lamp, open.

H-3 lamp through ultra-violet filter.

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Spectra of H-3 Lamp.

PLATE 2